CHAPTER 8

RESPONDING TO POTENTIAL BIOLOGICAL, CHEMICAL AND NUCLEAR/RADIOLOGICAL TERRORISM AGENTS

CHAPTER 8

RESPONDING TO POTENTIAL BIOLOGICAL, CHEMICAL AND NUCLEAR/RADIOLOGICAL TERRORISM AGENTS

INTRODUCTION

Chemical and biological agents differ in several important ways. Chemical agents are typically manmade through the use of industrial chemical processes. Biological agents are either replicating agents (bacteria or viruses) or nonreplicating materials (toxins or physiologically active proteins or peptides) that can be produced by living organisms. Nuclear/radiological threats primarily derive from the release of ionizing radiation from a deliberate attack with a nuclear or radiological bomb. The first section of this chapter will focus on biological agents, the second part on chemical agents. The chapter ends with a discussion of potential nuclear and radiological exposures.

Note that there is significant overlap in the symptoms caused by and initial responses to biological and chemical agents. Wherever appropriate, discussion will describe approaches to both biological and chemical agents.

HISTORY OF BIOLOGICAL AGENTS

The use of biological agents and efforts to make them more useful as a weapon affecting humans has been recorded numerous times throughout history. In the early 6th century BC, Assyrians were documented to have poisoned their enemies' wells with rye ergot. In 1346, plague broke out within the Tarter Army during their siege of Kaffa. They hurled the plague stricken corpses over the city walls and introduced an epidemic among the defenders. Some historians feel this to be the initiation of the Black Death pandemic that spread throughout Europe.

It is felt that the English provided smallpox-laden blankets to Indians loyal to the French during the French and Indian War from 1754 to 1767. The Japanese started an ambitious biological warfare program in 1937. A plague epidemic in China and Manchuria in 1940 followed reported over-flights by Japanese airplanes releasing plague-infested fleas.

In 1978, a Bulgarian exile named Georgi Markov was attacked in London by an umbrella device that injected a ricin laden pellet into his leg. He died several days later. Over many years, various countries have been documented to have some type of offensive biological development program. It is therefore prudent that we be aware of the most likely agents to be used and what we can do to counter and treat these agents.

BIOLOGICAL AGENTS

Bioterrorism is a threat in the marine environment, as it is on land. Thus, it is important for persons afloat to be familiar with potential threats, and especially critical for those responsible for health care underway to have an understanding of the medical aspects of bioterrorism.

Medical defense against and treatment for biological terrorism is an unfamiliar area to most providers of health care during peacetime. However, effective medical countermeasures are available against many of the bacteria, viruses, and toxins that might be used as biological weapons against people. The goal of this section is to serve as a reference and to help the reader develop an understanding of the biological threats and the medical supplies useful in defending against these threats.

The global biological terrorism threat is serious, and the potential for devastating casualties is high for certain biological agents. However, with appropriate use of medical countermeasures either already developed or under development, the illness and death can be greatly reduced.

DISTINGUISHING BETWEEN NATURAL AND INTENTIONAL DISEASE OUTBREAKS

The potential mechanisms of release of a biologic agent are many. Contaminated food or water sources are certainly a possibility. As much as possible, food and water should be obtained from reputable and secure sources. Biologic agent exposure could come in the form of an aerial release from an aircraft, from an exploded munition or from an aerosolizing device. Crewmembers should be wary of suspicious persons in or around the ship and of suspicious packages, parcels, etc. However, in spite of precautions taken, it is likely that the initial exposure to the biological agent will be undetected.

Therefore, a covert biological agent attack may first be apparent if many patients become sick with similar symptoms due to the released disease agent. However, many diseases caused by weaponized biological agents present with nonspecific clinical features that could seem like other, more common diseases. Table 1 identifies factors that may suggest there has been a biologic attack. While a helpful guide, these features can also be present in a naturally occurring disease outbreak. Conversely, a bioterrorist attack may have none of these features.

- The presence of an unexpected or unusual disease
- The presence of a large epidemic with a similar disease or syndrome
- More severe disease than is usually expected for a specific biologic agent or failure to respond to standard therapy
- Unusual routes of exposure for a biologic agent, such as the inhalational route for diseases that normally occur through other exposures
- A disease that is unusual for a given geographic area or transmission season
- Disease normally transmitted by a vector that is not present in the local area
- Multiple simultaneous or serial epidemics of different diseases in the same population
- A single case of disease by an uncommon agent (smallpox, some viral hemorrhagic fevers)
- A disease that is unusual for an age group
- Unusual strains or variants of organisms
- Higher attack rates in those exposed in certain areas, such as inside a building if released indoors, or lower rates in those inside a sealed building if released outside
- Disease outbreaks of the same illness occurring in noncontiguous areas
- A disease outbreak with an impact on animals as well as humans
- Intelligence of a potential attack, claims by a terrorist or aggressor of a release, and/or discovery of munitions or tampering

Table 1. Features that may be Present with a Biologic Warfare or Terrorist Attack

The following guiding principles should be followed whether a biological or chemical attack is suspected.

I. Maintain an index of suspicion. The shipboard health-care provider must always suspect that a disease may be due to biological weapons. An early suspicion is needed for a rapid diagnosis that is essential for the early treatment needed to save the patient's life.

II. Protect Thyself. Before you approach a potential biological casualty, you must first take steps to protect yourself - using physical, pharmacological, and/or immunologic tools. Physical protection is often a protective mask such as a HEPA-filter or simple surgical mask. These provide adequate protection against most biological (although not against chemical) threats. Pharmacological protection includes the pre- and/or post-exposure administration of antibiotics and/or antidotes. Immunological protection involves vaccines, which are generally not available for most bio-terrorism diseases. Deliberate physical protection against chemical agents

involves more sophisticated Personnel Protective Equipment (PPE). PPE is more fully described in the section on Nuclear Radiation.

III. Assess the Patient. First use the "ABC's" – airway, breathing and circulation. The initial "ABC's" assessment begins before decontamination and should be brief. A patient history may include questions about illnesses in other personnel, the presence of unusual food and water sources, vector exposure, immunization history, travel history, occupational duties, and personal protection status. Physical exam should focus on the pulmonary (lung) and neuromuscular (nerve and muscle) systems, as well as any unusual dermatologic (skin) and vascular (blood vessel/heart) findings

IV. Decontaminate as Appropriate. The incubation period of biological agents makes it unlikely that victims of a bio-terrorism attack will present for medical care until days after an attack, when the need for decontamination is past. If decontamination is needed, simple soap and water bathing will usually suffice. Certainly, standard decontamination solutions (such as hypochlorite), typically employed in cases of chemical agent contamination, would be effective against all biological agents (more information is provided in the decontamination section of this chapter). In fact, even 0.5% bleach can kill anthrax spores, the hardiest of biological agents. Exercise caution when using caustic substances, especially on human skin.

V. Establish a Diagnosis. Following decontamination (where warranted), the focus is making a diagnosis. Diagnostic specimens should be obtained from representative patients and these should be sent to the clinical laboratory. Nasal swabs (important for culture and PCR (a test for exposure to certain biologic agents), even if you are unsure which organisms to test for), blood cultures, serum, sputum cultures, blood and urine for toxin analysis, throat swabs, and environmental samples should be considered and obtained, if possible.

Without laboratory confirmation, a presumptive diagnosis must be made on clinical grounds. Chemical and biological terrorism diseases can be generally divided into those that present "immediately" with little or no incubation period (principally the chemical agents) and those with a longer incubation period (principally the biological agents). Moreover, bio-terrorism diseases are likely to present as one of a limited number of clinical syndromes. Plague, tularemia, and Staphylococcal Enterotoxin B (SEB) disease all may present as pneumonia. Botulism and Venezuelan Equine Encephalitis (VEE) may present with peripheral and central neuromuscular findings, respectively. Table 2 provides additional information.

RESPIRATORY	
Rapid-Onset	**Delayed-Onset**
▪ Nerve Agents ▪ Cyanide ▪ Mustard ▪ SEB Inhalation (biologic)	▪ Inhalational Anthrax ▪ Pneumonic Plague ▪ Pneumonic Tularemia ▪ Q Fever ▪ SEB Inhalation ▪ Ricin Inhalation ▪ Mustard (chemical)
NEUROLOGICAL	
Rapid-Onset	**Delayed-Onset**
▪ Nerve Agents ▪ Cyanide	▪ Botulism-peripheral symptoms ▪ VEE-CNS symptoms

Table 2. Diagnostic Matrix: Chemical & Biological Casualties.

VI. Render Prompt Treatment. Treatment is usually most effective during the incubation period, before the patient is sick. Treatment of the suspected diagnosis, even if not "proven" by the laboratory, is often indicated. Table 3 lists diseases requiring prompt therapy. Persons with respiratory disease, such as patients with undifferentiated febrile illnesses who might have early anthrax, plague, or tularemia, may also be treated immediately. Doxycycline (an antibiotic), for example, is effective against most strains of *B. anthracis* (anthrax), *Y. pestis* (plague), and *F. tularensis* (tularemia) as well as against *C. burnetii* (Q fever) and the Brucellae (brucellosis). The antibiotics ciprofloxacin, and tetracyclines and fluoroquinolones might also be considered. Beginning such therapy just "buys time" for a definitive diagnosis, it is not a substitute for a precise diagnosis.

RESPIRATORY	
Rapid-Onset	**Delayed-Onset**
▪ Cyanide	▪ Inhalational Anthrax ▪ Pneumonic Plague ▪ Pneumonic Tularemia
NEUROLOGICAL	
Rapid-Onset	**Delayed-Onset**
▪ Nerve Agents	▪ Botulism-peripheral symptoms

Table 3. Chemical and Bio-Terrorism Diseases Potentially Requiring Prompt Empiric Therapy.

VII. Practice Good Infection Control. Standard precautions provide adequate protection against most infectious diseases, including potential bio-terrorist agents. Anthrax, tularemia, brucellosis, glanders, Q-Fever, VEE, and the toxin-mediated diseases are not generally contagious (transmitted person to person), and victims can be safely managed using standard precautions. Under certain circumstances, however, transmission-based precautions would be warranted. For example,

smallpox victims should, wherever possible, be managed using airborne precautions. Pneumonic Plague warrants the use of droplet precautions, and certain Viral Hemorrhagic Fevers (VHFs) require contact precautions. (see section on "Patient Isolation Precautions")

Note: Hypochlorite solution (household bleach), and other disinfectants, are toxic. Keep away from eyes and sensitive tissues.

VIII. Alert the Proper Authorities. The ship's captain should immediately be notified of any suspected terrorist-related illnesses and/or injuries. In addition, the port authorities, law enforcement and public health officials at the next port of entry must be notified.

BACTERIAL AGENTS

Bacteria generally cause disease in human beings and animals by invading host tissues or by producing toxins (poisons). Many disease-causing bacteria utilize both mechanisms. Bacterial diseases usually respond antibiotic therapy. Under special circumstances some types of bacteria can transform into spores. The spore of the bacterial cell is more resistant to cold, heat, drying, chemicals and radiation than the bacterium itself. Spores are a dormant form of the bacterium and like the seeds of plants, they can germinate (grow) when conditions are favorable.

ANTHRAX (INHALLATION)

Signs and Symptoms: Incubation period is generally 1-6 days, although longer periods have been noted. Fever, malaise, fatigue, cough and mild chest discomfort progresses to severe respiratory distress with shortness of breath, sweating, stridor, bluish-tinged skin, and shock. Death typically occurs within 24-36 hours after onset of severe symptoms.

Diagnosis: Physical findings are non-specific. A widened mediastinum may be seen on Chest X-ray (CXR) in later stages of illness. The organism is detectable by Gram's stain of the blood and by blood culture late in the course of illness.

Treatment: Although effectiveness may be limited after symptoms are present, high dose (often intravenous) antibiotic treatment with ciprofloxacin, doxycycline or penicillin should be undertaken. Supportive therapy may be necessary.

Prophylaxis: Oral ciprofloxacin or doxycycline for known or imminent exposure. An FDA-licensed vaccine is only available for military personnel at the present time.

Isolation and Decontamination: Standard precautions for healthcare workers. This disease is not transmissible person-to-person. Environmental decontamination can be accomplished with a 0.5% hypochlorite solution.

BRUCELLOSIS

Signs and Symptoms: Illness typically presents with fever, headache, muscle pain, joint pain, back pain, sweats, chills, and generalized malaise. Other manifestations

include depression, mental status changes, and vertebral osteomyelitis. Fatalities are uncommon.

Diagnosis: Diagnosis requires a high index of suspicion, since many infections present as non-specific febrile illnesses or are asymptomatic.

Treatment: Antibiotic therapy with doxycycline and rifampin or doxycycline in combination with other medications (such as an aminoglycoside) for six weeks is usually sufficient in most cases.

Prophylaxis: No human vaccine is available against brucellosis. Antibiotic prophylaxis should be considered for high-risk exposure to a confirmed biological terrorism exposure.

Isolation and Decontamination: Standard precautions are appropriate for providers of healthcare. Person-to-person transmission has been reported via tissue transplantation and sexual contact. Environmental decontamination can be accomplished with a 0.5% hypochlorite solution.

GLANDERS AND MELIOIDOSIS

Signs and Symptoms: Incubation period ranges from 10-14 days after inhalation. Onset of symptoms may be abrupt or gradual. Inhalational exposure produces fever (common in excess of 102^{o}F.), shaking chills, sweats, muscle pain, headache, chest pain with respirations, enlarged cervical lymph nodes, enlarged liver and/or spleen, and generalized papular/pustular eruptions. Acute pulmonary disease can progress and result in bacteria in the blood and acute blood poisoning. Both diseases are almost always fatal without treatment.

Diagnosis: Chest x-ray may show seed-like lesions, small multiple lung abscesses, or infiltrates involving upper lungs, with solidification and cavitation.

Treatment: Therapy will vary with the type and severity of the clinical presentation but may include sulfonamides, tetracyclines and chloramphenicol. Patients with localized disease may be managed with oral antibiotics for a duration of 60-150 days. More severe illness may require intravenous therapy and more prolonged treatment.

Prophylaxis: Currently, no pre-exposure or post-exposure prophylaxis is available.

Isolation and Decontamination: Standard Precautions for healthcare workers. Person-to-person airborne transmission is unlikely, although secondary cases may occur through improper handling of infected secretions. Contact precautions are indicated while caring for patients with skin involvement. Environmental decontamination using a 0.5% hypochlorite solution is effective.

PLAGUE

Signs and Symptoms: Pneumonic plague begins after an incubation period of 1-6 days, with high fever, chills, headache, malaise, followed by cough (often with blood),

progressing rapidly to shortness of breath, stridor, bluish-tinged skin, and death. Gastrointestinal symptoms are often present. Death results from respiratory failure, circulatory collapse, and a bleeding abnormality. Bubonic plague, featuring high fever, malaise, and painful lymph nodes (buboes) may progress spontaneously to the septicemic form (septic shock, thrombosis, DIC) or to the pneumonic (lung) form.

Diagnosis: Suspect plague if large numbers of previously healthy individuals develop severe pneumonia, especially if coughing of blood is present. Definitive diagnosis requires culture of the organism.

Treatment: Early administration of antibiotics is critical, as pneumonic plague is invariably fatal if antibiotic therapy is delayed more than 1 day after the onset of symptoms. Choose one of the following: streptomycin, gentamicin, ciprofloxacin, or doxycycline for 10-14 days. Chloramphenicol is the drug of choice for plague meningitis.

Prophylaxis: For asymptomatic persons exposed to a plague aerosol or to a patient with suspected pneumonic plague, give doxycycline 100 mg orally twice daily for seven days or the duration of risk of exposure plus one week. Alternative antibiotics include ciprofloxacin, tetracycline, or chloramphenicol. No vaccine is currently available for plague prophylaxis. The previously available licensed, killed vaccine was effective against bubonic plague, but not against aerosol exposure.

Isolation and Decontamination: Use Standard Precautions for bubonic plague, and Respiratory Droplet Precautions for suspected pneumonic plague. *Y. pestis* can survive in the environment for varying periods, but is susceptible to heat, disinfectants, and exposure to sunlight. Soap and water is effective if decontamination is needed. Take measures to prevent local disease cycles if vectors (fleas) and reservoirs (rodents) are present.

Q FEVER

Signs and Symptoms: Fever, cough, and chest pain with respirations may occur as early as ten days after exposure. Patients are not generally critically ill, and the illness lasts from 2 days to 2 weeks.

Diagnosis: Q fever is not a clinically distinct illness and may resemble a viral illness or other types of atypical pneumonia. The diagnosis is confirmed by a blood test.

Treatment: Q fever is generally a self-limited illness even without treatment, but tetracycline or doxycycline should be given orally for 5 to 7 days to prevent complications of the disease. Q fever endocarditis (rare) is much more difficult to treat.

Prophylaxis: Antibiotic prophylaxis begun too early during the incubation period may delay but not prevent the onset of symptoms. Therefore, tetracycline or

doxycycline should be started 8-12 days post exposure and continued for 5 days. This regimen has been shown to prevent clinical disease.

Isolation and Decontamination: Standard Precautions are recommended for healthcare workers. Person-to-person transmission is rare. Patients exposed to Q fever by aerosol do not present a risk for secondary contamination or re-aerosolization of the organism. Decontamination is accomplished with soap and water or a 0.5% chlorine solution.

TULAREMIA

Signs and Symptoms: Ulceroglandular tularemia presents with a local ulcer and regionally enlarged lymph nodes, fever, chills, headache and malaise. Typhoidal tularemia presents with fever, headache, malaise, substernal discomfort, prostration, weight loss and a non-productive cough.

Diagnosis: Clinical diagnosis. Physical findings are usually non-specific. Chest x-ray may reveal a pneumonic (lung) process, enlarged mediastinal lymph nodes or pleural effusion (fluid in the lung spaces). Routine culture is possible but difficult. The diagnosis can be established retrospectively by a blood test.

Treatment: Administration of antibiotics (streptomycin or gentamicin) with early treatment is very effective.

Prophylaxis: A two-week course of tetracycline is effective as prophylaxis when given after exposure.

Isolation and Decontamination: Standard Precautions for healthcare workers. Organisms are relatively easy to render harmless by mild heat (55° C for 10 minutes) and standard disinfectants.

VIRAL AGENTS

Viruses are the simplest microorganisms and consist of a nucleocapsid protein coat containing genetic material, either RNA or DNA. Antibiotics do not have an effect on viruses. This chapter covers three types of viruses that could potentially be employed as bio-terrorism agents: smallpox, alphaviruses (e.g., VEE), and viral hemorrhagic fever (VHF) viruses.

SMALLPOX

Signs and Symptoms: Clinical manifestations begin acutely with malaise, fever, shaking chills, vomiting, headache, and backache. 2-3 days later lesions appear which quickly progress from macules to papules, and eventually to pustular vesicles. They are more abundant on the extremities and face, and develop synchronously.

Diagnosis: Clinical suspicion is based on the presentation of the above symptoms.

Treatment: At present there is no effective medication therapy, and treatment of a clinical case remains supportive.

Prophylaxis: Immediate vaccination or revaccination should be undertaken for all personnel exposed.

Isolation and Decontamination: Droplet and Airborne Precautions for a minimum of 17 days following exposure for all contacts. Patients should be considered infectious until all scabs separate and quarantined during this period. Strict quarantine of asymptomatic contacts should be done. If quarantine is not possible, require contacts to check their temperatures daily. Any fever above 38° C (101° F) during the 17-day period following exposure to a confirmed case would suggest the development of smallpox. The contact should then be isolated immediately until smallpox is either confirmed or ruled out and remain in isolation until all scabs separate.

VENEZUELAN EQUINE ENCEPHALITIS (VEE)

Signs and Symptoms: Incubation period 1-6 days. Acute systemic febrile illness with encephalitis develops in a small percentage (4% children; < 1% adults). Generalized malaise, spiking fevers, shaking chills, severe headache, pain in the eyes with exposure to light, and muscle pain for 24-72 hours may be seen. Nausea, vomiting, cough, sore throat, and diarrhea may follow. Full recovery from malaise and fatigue takes 1-2 weeks. The incidence of CNS disease and associated morbidity and mortality would be much higher after a bio-terrorism attack.

Diagnosis: Clinical diagnosis. Physical findings are non-specific.

Therapy: Treatment is supportive only. Treat uncomplicated VEE infections with analgesics to relieve headache and myalgia. Patients who develop encephalitis may require anticonvulsants and intensive supportive care to maintain fluid and electrolyte balance, ensure adequate ventilation, and avoid complicating secondary bacterial infections.

Prophylaxis: There is no post-exposure prophylaxis.

Isolation and Decontamination: Patient isolation and quarantine is not required. Standard Precautions augmented with vector control while the patient is febrile. There is no evidence of direct human-to-human or horse-to-human transmission. The virus can be destroyed by heat (80oC for 30 min) and standard disinfectants.

VIRAL HEMORRHAGIC FEVERS (VHF)

Signs and Symptoms: VHFs are febrile illnesses that can feature flushing of the face and chest, petechiae, bleeding, edema, abnormally low blood pressure, and

shock. Malaise, muscle pain, headache, vomiting, and diarrhea may occur in any of the hemorrhagic fevers.

Diagnosis: Definitive diagnosis rests on specific viral lab tests. Significant numbers of personnel with a hemorrhagic fever syndrome should suggest the diagnosis of a viral hemorrhagic fever.

Treatment: Intensive supportive care may be required. Antiviral therapy with ribavirin may be useful in several of these infections (available only as Investigational New Drug under protocol).

Prophylaxis: The only licensed VHF vaccine is yellow fever vaccine. Prophylactic ribavirin may be effective for Lassa fever, Rift Valley fever, and Crimean-Congo Hemorrhagic Fever (CCHF) (available only as IND under protocol).

Isolation and Decontamination: Contact isolation, with the addition of a surgical mask and eye protection for those coming within three feet of the patient, is indicated for suspected or proven Lassa fever, CCHF, or filovirus (Ebola, Marburg) infections. Respiratory protection should be upgraded to airborne isolation, including the use of a fit-tested HEPA-filtered respirator, a battery powered air-purifying respirator, or a positive pressure supplied air respirator, if patients with the above conditions have prominent cough, vomiting, diarrhea, or hemorrhage. Decontamination is accomplished with hypochlorite or phenolic disinfectants.

BIOLOGICAL TOXINS

Toxins are harmful substances produced by living organisms (animals, plants, microbes). Features that distinguish them from chemical agents, such as VX, cyanide, or mustard, include being not man-made, non-volatile (no vapor hazard), usually not dermally (skin) active (mycotoxins are the exception), and generally much more toxic per weight than chemical agents.

This chapter will cover four toxins considered to be among the most likely to be used against U.S. military and civilian targets: botulinum toxins, ricin, staphylococcal enterotoxin B (SEB), and T-2 mycotoxins.

BOTULINUM

Signs and Symptoms: Usually begins with cranial nerve palsies, including ptosis, blurred vision, double vision, dry mouth and throat, difficulty swallowing, and altered voice. This is followed by symmetrical descending flaccid (weak, soft) paralysis, with generalized weakness and progression to respiratory failure. Symptoms begin as early as 12-36 hours after inhalation, but may take several days after exposure to low doses of toxin.

Diagnosis: Diagnosis is primarily a clinical one. A bioterrorism attack should be suspected if multiple casualties simultaneously present with progressive descending flaccid paralysis.

Treatment: Early administration of trivalent licensed antitoxin or heptavalent antitoxin (IND product) may prevent or decrease progression to respiratory failure and hasten recovery. Intubation and ventilatory assistance may be needed for respiratory failure. Tracheostomy may be required.

Prophylaxis: Vaccine is generally not available.

Isolation and Decontamination: Standard Precautions for healthcare workers. Toxin is not dermally (skin) active and secondary aerosols are not a hazard from patients. Decon with soap and water. Botulinum toxin is inactivated by sunlight within 1-3 hours. Heat (80^{O}C for 30 min., 100^{O}C for several minutes) and chlorine also destroy the toxin.

RICIN

Signs and Symptoms: Acute onset of fever, chest tightness, cough, shortness of breath, nausea, and joint pain occurs 4 to 8 hours after inhalational exposure. Airway necrosis and pulmonary capillary leak resulting in pulmonary edema would likely occur within 18-24 hours, followed by severe respiratory distress and death from hypoxemia (low blood oxygen) in 36-72 hours.

Diagnosis: Acute lung injury in large numbers of geographically clustered patients suggests exposure to aerosolized ricin. The rapid time course to severe symptoms and death would be unusual for infectious agents.

Treatment: Management is supportive and should include treatment for pulmonary edema. Gastric lavage and cathartics (emetics) are indicated for ingestion, but charcoal is of little value for large molecules such as ricin.

Prophylaxis: There is currently no vaccine or prophylactic antitoxin available for human use. Use of the protective mask is currently the best protection against inhalation.

Isolation and Decontamination: Standard Precautions for healthcare workers. Ricin is non-volatile, and secondary aerosols are not expected to be a danger to health care providers. Decontaminate with soap and water. Hypochlorite solutions (0.1% sodium hypochlorite) can inactivate ricin.

STAPHYLOCOCCAL ENTEROTOXIN B (SEB)

Signs and Symptoms: Latent period of 3-12 hours after aerosol exposure is followed by sudden onset of fever, chills, headache, muscle pain, and nonproductive cough. Some patients may develop shortness of breath and mid-chest pain.

Patients tend to plateau rapidly to a fairly stable clinical state. Fever may last 2 to 5 days, and cough may persist for up to 4 weeks. Patients may also present with nausea, vomiting, and diarrhea if they swallow the toxin. Presumably, higher exposure can lead to septic shock and death.

Diagnosis: Diagnosis is clinical. Patients will present with a febrile respiratory syndrome without CXR abnormalities. Large numbers of patients presenting in a short period of time with typical symptoms and signs of SEB pulmonary exposure would suggest an intentional attack with this toxin.

Treatment: Treatment is limited to supportive care. Artificial ventilation might be needed for very severe cases, and attention to fluid management is important.

Prophylaxis: Use of protective mask. There is currently no human vaccine available to prevent SEB intoxication.

Isolation and Decontamination: Standard Precautions for healthcare workers. SEB is not dermally active and secondary aerosols are not a hazard from patients. Decon with soap and water. Destroy any food that may have been contaminated.

T-2 MYCOTOXINS

Signs and symptoms: Exposure causes skin pain, itching, redness, vesicles, necrosis and shedding of the skin. Effects on the airway include nose and throat pain, nasal discharge, itching and sneezing, cough, shortness of breath, wheezing, chest pain and bloody sputum. Toxin also produces effects after ingestion or eye contact. Severe intoxication results in prostration, weakness, ataxia, collapse, shock, and death.

Diagnosis: Should be suspected if an aerosol attack occurs in the form of "yellow rain" with droplets of variously pigmented oily fluids contaminating clothes and the environment. Confirmation requires testing of blood, tissue and environmental samples.

Treatment: There is no specific antidote. Treatment is supportive. Soap and water washing, even 4-6 hours after exposure can significantly reduce dermal toxicity; washing within 1 hour may prevent toxicity entirely. Superactivated charcoal should be given orally if the toxin is swallowed.

Prophylaxis: The only defense is to prevent exposure by wearing a protective mask and clothing (or topical skin protectant) during an attack. No specific immunotherapy or chemotherapy is available for use in the field.

Isolation and Decontamination: Outer clothing should be removed and exposed skin decontaminated with soap and water. Eye exposure should be treated with copious saline irrigation. Secondary aerosols are not a hazard; however, contact with contaminated skin and clothing can produce secondary dermal exposures. Contact

Precautions are warranted until decontamination is accomplished. Then, Standard Precautions are recommended for healthcare workers. Environmental decontamination requires the use of a hypochlorite solution under alkaline conditions such as 1% sodium hypochlorite and 0.1M NaOH with 1-hour contact time.

CHEMICAL AGENTS

For the purposes of this section, a chemical agent is one that is intended for use in intentional operations to kill, seriously injure, or incapacitate humans (or animals) through its toxicological effects. Toxic Industrial Compounds/Materials (TICS/TIMS) are certainly threats but are beyond the scope of this text. However, the general principles outlined within this chapter hold true regardless of the agent used. Refer to the guidelines in the bioagent section above for a generic approach to assessment. Additionally, decontamination procedures for chemical agents are analogous to the procedures followed for a suspected biological agent. This section will focus on Mustard, Nerve agents and Cyanide.

MUSTARD

Signs and symptoms: Symptoms may be delayed for 2-48 hours after exposure with 4-8 hours being the average time from exposure to onset of symptoms. Exposure may cause skin burns and necrosis, eye burns with ulceration and possible perforation, airway disease with shortness of breath, wheezing, and chest pain and suppression of the immune system. Severe intoxication results in prostration, weakness, seizures, collapse, shock, and death.

Diagnosis: Should be suspected if an aerosol attack occurs in the form of a vapor with symptoms as outlined above or contact with an oily yellow to brownish liquid is encountered.

Treatment: Skin: Soothing creams to burns, analgesics, antibiotics to treat/prevent infection. Eyes: Soothing eye drops, topical mydriatics, topical antibiotics, and sunglasses. Airways: Steam, oxygen, bronchodilators, cough suppressants, ventilatory support. GI: antiemetics, fluid support, electrolyte replacement.

Prophylaxis: The only defense is to prevent exposure by wearing a protective mask and clothing (or topical skin protectant) during an attack.

Isolation and Decontamination: Outer clothing should be removed and exposed skin decontaminated with soap and water. Eye exposure should be treated with copious saline irrigation. Grossly contaminated skin surfaces should be washed with a 0.5% sodium hypochlorite solution, if available, with a contact time of 10 to 15 minutes. Environmental decontamination requires the use of a hypochlorite solution under alkaline conditions such as 5% sodium hypochlorite or 0.1M NaOH with 1-hour contact time.

NERVE AGENTS

Nerve agents can function as both a liquid and vapor hazard. The primary effect is to disrupt the normal function of nerve endings creating a number of symptoms that can lead to death. These agents operate on the same mechanisms as many commercially available insecticides and are often referred to as pesticides for humans.

Signs and symptoms: Exposure causes shortness of breath, wheezing, chest pain and increased secretions from the lungs, nose, eyes, mouth and GI system, including nausea, vomiting and diarrhea. Pupils become very small. Severe intoxication results in prostration, weakness, seizures, collapse, shock, and death.

Diagnosis: Should be suspected if an aerosol attack occurs in the form of a vapor with symptoms as outlined above.

Treatment: Atropine 2-6 mg IM depending on severity. Continue using atropine at 2 mg every 5-10 minutes until secretions are drying up and respiratory symptoms have improved. Use Diazepam, 10 mg IM, for seizures.

Prophylaxis: The only defense is to prevent exposure by wearing a protective mask and clothing (or topical skin protectant) during an attack.

Isolation and Decontamination: Outer clothing should be removed and exposed skin decontaminated with soap and water. Eye exposure should be treated with copious saline irrigation. Grossly contaminated skin surfaces should be washed with a 0.5% sodium hypochlorite solution, if available, with a contact time of 10 to 15 minutes. Environmental decontamination requires the use of a hypochlorite solution under alkaline conditions such as 5% sodium hypochlorite or 0.1M NaOH with 1-hour contact time.

CYANIDE

Cyanide agents function as a vapor hazard. The primary effect is to disrupt the normal function of the cells ability to utilize oxygen that can lead to death.

Signs and symptoms: Exposure causes a brief increase in respirations followed by respiratory distress. Severe intoxication results in prostration, weakness, seizures, collapse, shock, and death.

Diagnosis: Should be suspected if an aerosol attack occurs in the form of a vapor with symptoms as outlined above.

Treatment: 100% oxygen. Sodium Nitrite, 10 mL IV of a 3% soln (30 mg / mL) = 300 mg, administered over at least a 3-minute period followed by Sodium Thiosulfate, 50 mL IV of a 25% soln (250 mg / mL) = 12.5 g, administered over a 10-minute period beginning immediately after nitrite administration.

Prophylaxis: The only defense is to prevent exposure by wearing a protective mask and clothing (or topical skin protectant) during an attack.

Isolation and Decontamination: Outer clothing should be removed and exposed skin decontaminated with soap and water. Eye exposure should be treated with copious saline irrigation. Grossly contaminated skin surfaces should be washed with a 0.5% sodium hypochlorite solution, if available, with a contact time of 10 to 15 minutes. Environmental decontamination requires the use of a hypochlorite solution under alkaline conditions such as 5% sodium hypochlorite or 0.1M NaOH with 1-hour contact time.

DETECTION

Detector systems are evolving, and represent an area of intense interest with the highest priorities within the research and development community. However, until reliable detectors are available in sufficient numbers, usually the first indicator of a biological or chemical attack in unprotected people will be those who become ill.

DECONTAMINATION

Contamination is the introduction of an infectious or chemical agent on a body surface, food or water, or other inanimate objects. Decontamination involves either disinfection, sterilization or removal to reduce microorganisms or chemical agents to an acceptable level on contaminated articles, thus rendering them suitable for use. Disinfection is the selective reduction of undesirable microbes to a level below that required for transmission. Sterilization is the killing of all organisms.

Decontamination methods have always played an important role in the control of infectious diseases. However, we are often unable to use the most efficient means of rendering microbes or chemicals harmless (e.g., toxic chemical sterilization), as these methods may injure people and damage materials that are to be decontaminated. Though some sophisticated methods of decontamination may not be available underway, some fairly simple tools are available. Biological and chemical terrorism agents can be decontaminated by mechanical, chemical and physical methods:

- Mechanical decontamination involves measures to remove but not necessarily neutralize an agent. An example is the filtering of drinking water to remove certain water-borne biologic agents (e.g. *Dracunculus medinensis*), or in a bioterrorism context, the use of an air filter to remove aerosolized anthrax spores, or water to wash an agent from the skin.
- Chemical decontamination renders biological and chemical terrorism agents harmless by the use of disinfectants or decontaminants that are usually in the form of a liquid, gas or aerosol. Some of these products are harmful to humans, animals, the environment, and materials.

- Physical means (heat, radiation) are other methods that can be employed for decontamination of objects.

Dermal (skin) exposure to a suspected biological or chemical terrorism aerosol should be immediately treated by soap and water decontamination. Careful washing with soap and water removes nearly all of the agent from the skin surface. Hypochlorite solution or other disinfectants are reserved for gross biological contamination (i.e. following the spill of solid or liquid agent from a munition directly onto the skin). In the absence of chemical or gross biological contamination, these will confer no additional benefit, may be caustic, and may predispose to colonization and resistant superinfection by reducing the normal skin flora. Chemically or grossly biologically contaminated skin surfaces should be washed with a 0.5% sodium hypochlorite solution, if available, with a contact time of 10 to 15 minutes. **(Protect the eyes from <u>all</u> sodium hypochlorite solutions.)**

The 0.5% solution can be made by adding one 6-ounce container of calcium hypochlorite to five gallons of water. The 5% solution can be made by adding eight 6-ounce ampules of calcium hypochlorite to five gallons of water. These solutions evaporate quickly at high temperatures so if they are made in advance they should be stored in closed containers. Also the chlorine solutions should be placed in distinctly marked containers because it is very difficult to tell the difference between the 5% chlorine solution and the 0.5% solution.

To mix a 0.5% sodium hypochlorite solution, take one part Clorox and nine parts water (1:9) since standard stock Clorox is a 5.25% sodium hypochlorite solution. The solution is then applied with a cloth or swab. The solution should be made fresh daily with the pH in the alkaline range.

Chlorine solution must NOT be used in (1) open body cavity wounds, as it may lead to the formation of adhesions, or (2) brain and spinal cord injuries (3) eyes. However, this solution may be instilled into non-cavity wounds and then removed by suction to an appropriate disposal container. Within about 5 minutes, this contaminated solution will be neutralized and nonhazardous. Subsequent irrigation with saline or other surgical solutions should be performed. **(Prevent the chlorine solution from being sprayed into the eyes, as corneal opacities may result.)**

For decontamination of fabric clothing or equipment, a 5% hypochlorite solution should be used. For decontamination of equipment, a contact time of 30 minutes prior to normal cleaning is required. This is corrosive to most metals and injurious to most fabrics, so rinse thoroughly and oil metal surfaces after completion.

Bioterrorism agents can be rendered harmless through such physical means as heat and radiation. To render agents completely harmless, sterilize with dry heat for two hours at 160 degrees centigrade. If autoclaving with steam at 121 degrees centigrade and 1 atmosphere of overpressure (15 pounds per square inch), the time may be reduced to 20 minutes, depending on volume. Solar ultraviolet (UV) radiation

has a disinfectant effect, often in combination with drying. This is effective in certain environmental conditions but hard to standardize for practical usage for decontamination purposes.

PATIENT ISOLATION PRECAUTIONS

These precautions are most suitable when dealing with personnel with suspected/known biological infection.

Standard Precautions

- Wash hands after patient contact.
- Wear gloves when touching blood, body fluids, secretions, excretions and contaminated items.
- Wear a mask and eye protection, or a face shield during procedures likely to generate splashes or sprays of blood, body fluids, secretions or excretions
- Handle used patient-care equipment and linen in a manner that prevents the transfer of microorganisms to people or equipment.
- Use care when handling sharps and use a mouthpiece or other ventilation device as an alternative to mouth-to-mouth resuscitation when practical.

Standard precautions are employed in the care of ALL patients.

Airborne Precautions

Standard Precautions plus:

- Place the patient in a private room that has monitored negative air pressure, a minimum of six air changes/hour, and appropriate filtration of air before it is discharged from the room.
- Wear respiratory protection when entering the room.
- Limit movement and transport of the patient. Place a mask on the patient if they need to be moved.

Biothreat Diseases requiring Airborne Precautions: Smallpox.

Droplet Precautions

Standard Precaution plus:

- Place the patient in a private room or cohort them with someone with the same infection. If not feasible, maintain at least 3 feet between patients.
- Wear a mask when working within 3 feet of the patient.
- Limit movement and transport of the patient. Place a mask on the patient if they need to be moved.

Biothreat Diseases requiring Droplet precautions: Pneumonic Plague.

Contact Precautions

Standard Precautions plus:

- Place the patient in a private room or cohort them with someone with the same infection if possible.
- Wear gloves when entering the room. Change gloves after contact with infective material.
- Wear a gown when entering the room if contact with patient is anticipated or if the patient has diarrhea, a colostomy or wound drainage not covered by a dressing.
- Limit the movement or transport of the patient from the room.
- Ensure that patient-care items, bedside equipment, and frequently touched surfaces receive daily cleaning.
- Dedicate use of non-critical patient-care equipment (such as stethoscopes) to a single patient, or group of patients with the same disease. If not feasible, adequate disinfection between patients is necessary.

Biothreat Diseases requiring Contact Precautions: Viral Hemorrhagic Fevers.

NUCLEAR RADIATION

Ionizing radiation is a concern in the event of a nuclear explosion in the vicinity of a vessel. The effects of partial body exposure to radiation depend on the dose and site of the exposure. Other organs frequently affected by local exposure include the skin and reproductive organs. Effects on bone marrow and the gastrointestinal system occur when these organs are the targets of the exposure. Signs and symptoms of exposure, such as nausea and decreased white blood cells and platelets, are also seen when radiation is used in the treatment of cancer.

Cancer is a major long-term health effect of ionizing radiation. The reasons for this effect are not yet fully understood, but are likely to be related to changes produced in the DNA, the genetic material of cells. These changes may involve several steps that take years to progress to the onset of cancer. In an emergency situation, you may know only that a material is radioactive without knowing which type of radiation is being emitted.

TYPES OF RADIATION

There are several types of radiation present in nature and manmade sources:

- Alpha particles
- Beta particles

- Gamma rays
- X-rays
- Neutrons

Alpha Particles

Alpha particles are the slowest of the types of radiation. They can travel only a few inches in the air, losing their energy almost as soon as they collide with anything. They can easily be shielded by a sheet of paper or the outer layer of a person's skin. An alpha particle has a large mass and two protons, two neutrons, and no electrons. Because it has two protons and no electrons, it is positively charged. When emitted from the nucleus, the positive charge causes the alpha particle to strip electrons from nearby atoms as it passes.

Alpha particles are extremely hazardous to fire fighters and other exposed personnel because they can be inhaled and deposited in body tissues, where they can cause severe long-term health effects. Positive pressure Self-Contained Breathing Apparatus (SCBA) is effective protection against inhaling alpha particles. These agents can affect the cells of the body in various ways, and each is capable of destroying cells.

Beta Particles

Beta particles are more energetic than alpha particles. They travel in the air for a distance of a few feet. Beta particles can pass through a sheet of paper but may be stopped by a sheet of aluminum foil or glass. A beta particle has a small mass and is usually negatively charged. It is emitted from the nucleus of an atom with a charge of minus one. Beta radiation causes ionization by interfering with electrons in their orbits. Both have a negative charge, so the electrons are repelled when the beta particle passes. Beta particles can damage the skin or tissues of the eye. Internally, they can be extremely damaging if they concentrate in specific tissues.

Gamma Rays

Gamma rays (unlike alpha or beta particles) are waves of pure energy; they have no mass. They are emitted from the nucleus of an atom and travel at the speed of light (186,000 miles per second). Gamma radiation can be very penetrating and requires concrete, lead or steel to stop it.

X-Rays

X-rays are essentially the same as gamma rays except that they are emitted from the electrons that orbit the atom's nucleus, rather than from the nucleus itself. Gamma rays and X-rays are also called photons. Because they have very high energy and penetrate deeply, gammas and X-rays can affect not only specific organs, but the surrounding tissues as well.

Neutron Particles

Neutrons are particles normally contained in the nucleus of an atom. They can be released through certain manufacturing processes, such as nuclear fission (splitting an atomic nucleus). Neutrons are considerably larger than beta particles but have only one-fourth the mass of alpha particles. Because they can penetrate even thick lead shields, they can be extremely damaging to humans. However, neutron radiation is very rare since it is generally emitted only when atomic weapons are detonated.

LIMITING EXPOSURE

You can minimize your exposure to any type of radiation by:

1. Limiting the time that you are near the source of radiation
2. Increasing the distance between yourself and the source
3. Shielding yourself with appropriate protective clothing

Time

The shorter the time you are exposed to radiation, the less your exposure. Work quickly and efficiently; rotate teams to keep individual exposures to a minimum.

Distance

The farther you are from a source of radiation, the lower the dose you receive. If you must approach low level radioactive materials, do not touch them; use shovels or brooms and avoid physical contact.

Shielding

SCBA and bunker gear shields you from most alpha and beta radiation. Several inches of lead are necessary to shield you from gamma radiation. If possible, use clothing, vehicles, equipment, containers or natural barriers like hills, trees, and rocks to protect yourself from radiation exposure. However, be aware that your apparatus, depending on its profile and construction material, may not provide adequate shielding. Shielding also includes covering the source itself. For example, you may be able to prevent exposure to alpha and some beta radiation if you cover the source with a drum or heavy material, such as a tarp.

Like other exposures, if your clothing or skin is contaminated with a radioactive substance, exposure will continue until you are decontaminated.

MEDICAL TREATMENT

Potassium iodide (KI), if taken in time, blocks the thyroid gland's uptake of radioactive iodine and thus could help prevent thyroid cancers and other diseases that might otherwise be caused by exposure to airborne radioactive iodine that could be dispersed in a nuclear accident. KI provides protection only for the thyroid from

radioiodines. It has no impact on the uptake by the body of other radioactive materials and provides no protection against external irradiation of any kind. FDA emphasizes that the use of KI should be as an adjunct to evacuation (itself not always feasible), sheltering, and control of foodstuffs. Dosage: One (1) 130 mg tablet once a day. Take for 10 days unless directed otherwise by State or local public health authorities.

PERSONAL PROTECTIVE EQUIPMENT (PPE) AND RADIATION

Clothing that covers skin also offers protection from some forms of radiation. (Note: the PPE level A description below also offers excellent protection from biological and chemical agents) However, it will not keep you from becoming exposed. A person dressed in level A clothing (see below) (hood, SCBA, coat, pants, boots and gloves) is well protected from surface contamination. If you should become contaminated by a liquid or solid (not airborne) hazardous material, taking off your outer clothing should remove most of the contamination. Airborne contamination is more dangerous. If a radioactive contaminant enters your body through a cut in your skin, or if you inhale radioactive particles, the material will remain inside your body and continue to expose the surrounding tissue. The best protection against internal contamination is SCBA. Always wear your SCBA when airborne radiation (or any other airborne hazard, for that matter) is suspected. Remember that alpha particles will not penetrate the skin, so your regular protective clothing will offer sufficient skin protection.

However, alpha radiation can cause very serious problems if it is inhaled. Although beta radiation can be stopped by a thin piece of metal, regular PPE offers little protection. Furthermore, inhalation of particles can cause extensive damage. Gamma rays can penetrate lead, so PPE gear will not keep you from exposure to this type of radiation.

The following are guidelines which an employer can use to begin the selection of the appropriate PPE. As noted above, the site information may suggest the use of combinations of PPE selected from the different protection levels (i.e., A, B, C, or D) as being more suitable to the hazards of the work. It should be cautioned that the listing below does not fully address the performance of the specific PPE material in relation to the specific hazards at the job site, and that PPE selection, evaluation and re-selection is an ongoing process until sufficient information about the hazards and PPE performance is obtained.

Part A. Personal protective equipment is divided into four categories based on the degree of protection afforded. (See Part B for further explanation of Levels A, B, C, and D hazards.)

I. Level A - To be selected when the greatest level of skin, respiratory, and eye protection is required.

The following constitute Level A equipment; it may be used as appropriate;

1. Positive pressure, full face-piece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH).

2. Totally-encapsulating chemical-protective suit.

3. Coveralls.(1)

4. Long underwear.(1)

5. Gloves, outer, chemical-resistant.

6. Gloves, inner, chemical-resistant.

7. Boots, chemical-resistant, steel toe and shank.

8. Hard hat (under suit).(1)

9. Disposable protective suit, gloves and boots (depending on suit construction, may be worn over totally-encapsulating suit).

Footnote: (1) Optional, as applicable.

II. Level B - The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.

The following constitute Level B equipment; it may be used as appropriate.

1. Positive pressure, full-face piece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA (NIOSH approved).

2. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls).

3. Coveralls.(1)

4. Gloves, outer, chemical-resistant.

5. Gloves, inner, chemical-resistant.

6. Boots, outer, chemical-resistant steel toe and shank.

7. Boot-covers, outer, chemical-resistant (disposable).(1)

8. Hard hat.(1)

9. Face shield.(1)

Footnote (1) Optional, as applicable.

III. Level C - The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air-purifying respirators are met.

The following constitute Level C equipment; it may be used as appropriate.

1. Full-face or half-mask, air-purifying respirators (NIOSH approved).

2. Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls).

3. Coveralls.(1)

4. Gloves, outer, chemical-resistant.

5. Gloves, inner, chemical-resistant.

6. Boots (outer), chemical-resistant steel toe and shank.(1)

7. Boot-covers, outer, chemical-resistant (disposable).(1)

8. Hard hat.(1)

9. Escape mask.(1)

10. Face shield.(1)

Footnote(1) Optional, as applicable.

IV. Level D - A work uniform affording minimal protection: used for nuisance contamination only.

The following constitute Level D equipment; it may be used as appropriate:

1. Coveralls.

2. Gloves.(1)

3. Boots/shoes, chemical-resistant steel toe and shank.

4. Boots, outer, chemical-resistant (disposable).(1)

5. Safety glasses or chemical splash goggles.(1)

6. Hard hat.(1)

7. Escape mask.(1)

8. Face shield.(1)

Footnote (1) Optional, as applicable.

Part B. The types of hazards for which levels A, B, C, and D protection are appropriate are described below:

I. Level A - Level A protection should be used when:

1. The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either the measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or the site operations and work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the skin,

2. Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible; or

3. Operations must be conducted in confined, poorly ventilated areas, and the absence of conditions requiring Level A have not yet been determined.

II. Level B – Level B protection should be used when:

1. The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection.

2. The atmosphere contains less than 19.5 percent oxygen; or

3. The presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin.

Note: This involves atmospheres with IDLH concentrations of specific substances that present severe inhalation hazards and that do not represent a severe skin hazard; or that do not meet the criteria for use of air-purifying respirators.

III. Level C - Level C protection should be used when:

1. The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin;

2. The types of air contaminants have been identified, concentrations measured, and an air-purifying respirator is available that can remove the contaminants; and

3. All criteria for the use of air-purifying respirators are met.

IV. Level D - Level D protection should be used when:

1. The atmosphere contains no known hazard; and

2. Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

Note: As stated before, combinations of personal protective equipment other than those described for Levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection

EFFECTS OF EXPOSURE

The effects of radiological exposures can be characterized two ways: as a result of whole body exposure or as a result of local exposure. Rem (R) (roentgen equivalent man) measures a quantity called “dose equivalent,” which relates the absorbed dose in human tissue to the resulting biological damage. This measurement is necessary because not all radiation has the same biological effect. These terms are discussed below.

Whole Body Exposure

Exposure of the entire body to a dose of 100 R or greater in a short time period (24 hours or less), results in signs and symptoms known as acute radiation syndrome. The radiation source in such cases is usually gamma or X-rays. Actual cases of unintentional whole-body radiation exposure have occurred only very rarely. Few symptoms are noted at doses under 100 R, but damage can be detected in white blood cells. Doses greater than 100 R result in progressively more threatening consequences that tend to follow a predictable time course. Doses of 100 to 200 R usually cause nausea and vomiting within hours of the exposure. Typical results of laboratory tests include a decrease in certain blood components, especially white blood cells, within two days. This effect is important because white blood cells play a major role in the immune system.

At doses from 200 to 600 R, the most critical problem is maintaining sufficient levels of circulating blood cells. This dose range is life threatening, especially if no treatment is received. White blood cells are most severely affected. At doses of 300 R or more, hair loss occurs after about two weeks.

With exposures between 600 and 1,000 R, chances for survival are decreased. Death may result from infection, hemorrhage, and other results of decreased bone marrow functioning, but may take months to occur. At doses greater than 1,000 R, cells of the small intestine lining are damaged and do not recover, resulting in infections and loss of fluid and electrolytes through the wall of the intestine. Death occurs within days.

Local Exposure

The effects of partial body exposure to radiation depend on the dose and site of the exposure. Other organs frequently affected by local exposure include the skin and reproductive organs. Effects on bone marrow and the gastrointestinal system occur when these organs are the targets of the exposure. Signs and symptoms of exposure, such as nausea and decreased white blood cells and platelets, are also seen when radiation is used in the treatment of cancer. Improper handling of gamma or beta sources or heavy exposure to X-ray, neutron, or other particle beams can result in radiation burns to the skin. These are classified like thermal burns – first, second, or third degree, depending on the extent of the injury. However, unlike thermal burns, they develop much more slowly, often taking days to become evident. Because of this, the cause of the burn is not always recognized.

GLOSSARY OF MEDICAL TERMS

Ataxia - An inability to coordinate muscle activity during voluntary movement, so that uncoordinated movements occur. May involve the limbs, head, or trunk.

Edema - An accumulation of an excessive amount of watery fluid in cells, tissues, or body cavities.

Endotracheal intubation - Passage of a tube through the nose or mouth into the trachea for maintenance of the airway during anesthesia or for maintenance of an imperiled airway.

HEPA - HEPA is an acronym for "high efficiency particulate arresting". These air purifiers effectively remove 99.97% of all pollen, mold spores, animal hair and dander, dust mites, bacteria, smoke particles and dust that pass though the air purifier.

Incubation period - The time period from exposure to biologic agent and the onset of symptoms.

Macula, pl. maculae - 1. A small spot, different in color from the surrounding tissue. 2. A small, discolored patch or spot on the skin, neither elevated above nor depressed below the skin's surface.

Malaise - Generalized body discomfort

Mediastinum - The middle partition of the thoracic cavity, containing all the chest organs and structures except the lungs.

Necrosis - Pathologic death of one or more cells, or of a portion of tissue or organ, resulting from irreversible damage.

Osteomyelitis - Inflammation of the bone marrow and adjacent bone.

Papule - A small, circumscribed, solid elevation on the skin.

Petechia, pl. petechiae - Minute hemorrhagic (blood) spots, of pinpoint to pinhead size, in the skin, which are not blanched by pressure.

Stridor - A high-pitched, noisy respiration, like the blowing of the wind; a sign of respiratory obstruction, especially in the trachea or larynx.

Vector - The carrier, usually an animal (e.g. mosquito), that transfers the biologic agent from one host to another.

SUMMARY

Though overall the risks of a specific terrorist event to any specific vessel may be low, the potential danger is great enough to warrant pre-planning and preparation. For providers of medical care, the key is to suspect a terrorist event if a patient's illness or injury seems strange or unusual, and then to have a plan to address the situation. This chapter has provided a basic introduction to this process. The medical aspects must be considered in the context of a larger emergency preparedness plan.

FIGURE 1. SOURCES OF INFORMATION ON NATURAL AND MANMADE DISASTERS

Federal Emergency Management Agency (FEMA)	www.fema.gov
U.S. Fire Administration	www.usfa.fema.gov
Department of Health and Human Services	www.hhs.gov
Department of Energy	www.energy.gov
U.S. Department of Agriculture	www.usda.gov
U.S. Department of Justice	www.justice.gov
National Weather Service	www.nws.noaa.gov
Centers for Disease Control and Prevention	www.cdc.gov
	www.bt.cdc.gov
U.S. Food and Drug Administration	www.fda.gov
Nuclear Regulatory Commission	www.nrc.gov
American Red Cross	www.redcross.org
Humane Society of the United States	www.hsus.org/disaster
Armed Forces Radiobiology Research Institute	www.afrri.usuhs.mil
Army Medical Research Institute of Chemical Defense	http://ccc.apgea.army.mil
NBC-Medical	www.nbc-med.org
Hazardous Materials Information (*Emergency Response Guidebook*)	http://hazmat.dot.gov http://dot.gov/gydebook.htm